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Investigation of the governance structure of the Nairobi dairy value chain and its influence on food safety

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ABSTRACT

The dairy value chain of Nairobi is comprised, in its majority, of small-scale independent enterprises that operate within a complex interlinked system. In this complexity, the coordination and power structures of the system may have major influences on the management of dairy food safety. Therefore, the aim of this study was to investigate the governance structure and challenges faced by stakeholders throughout the Nairobi dairy value chain and assess their potential implications on food safety. Qualitative data were collected through focus group discussions and key informant interviews based on a dairy value chain mapping framework previously developed. Thematic analysis enabled identification of governance themes, key challenges and analysis of their implications on food safety. Themes were organized depending on their association with farmers (informal settlement or peri-urban), dairy cooperatives, dairy traders, processing companies, retailers or government officers. The identified governance themes included: i) weak linkage between government and farmers, ii) inadequate compliance with government regulations by traders and retailers, iii) emphasis on business licenses and permits for revenue rather than for food safety, iv) multiple licensing resulting in high business cost and lack of compliance, v) fragmented regulation, vi) unfair competition and vii) sanctions that do not always result in compliance. The key challenges identified included, among others: i) inadequate farmer support, ii) harassment of traders and retailers and iii) high business costs for traders, retailers, dairy cooperatives and large processors. The implication of governance and challenges of food safety were, among others: i) inadequate extension services, ii) insufficient cold chain, iii) delivery of adulterated and low milk quality to bulking centers, iv) inadequate food safety training and v) lack of policies for management of waste milk. The range of issues highlighted are based on stakeholders' perceptions and reflects the complexity of the relationships between them. Many of the governance themes demonstrate the linkages that are both beneficial or confrontational between the formal and informal sectors, and between industry and regulatory authorities, with possible direct food safety consequences. Findings obtained provide indications to decision-makers of potential governance areas that could help improve efficiency and food safety along the dairy value chain.

1. Introduction

By 2050, demand for milk consumption will triple in Africa and particularly in East Africa driven by population growth, increasing urbanization and improved purchasing power due to economic growth (Herrero et al., 2014). Kenya is one of the countries in Africa with high milk consumption estimated to be between 50 and 100 L of milk per person annually (Bosire et al., 2017). The significance and prominence of the Kenya dairy sector is exemplified by its nutritional importance (Dominguez-Salas et al., 2016), its 3.5% contribution to the total gross domestic product (Muriuki et al., 2003), its economic value estimated at 230 million US dollars (Kaitibie et al., 2010) and creation of numerous job opportunities. The Food and Agriculture Organization of the United Nations (FAO) estimates that for every 1000 L of milk handled

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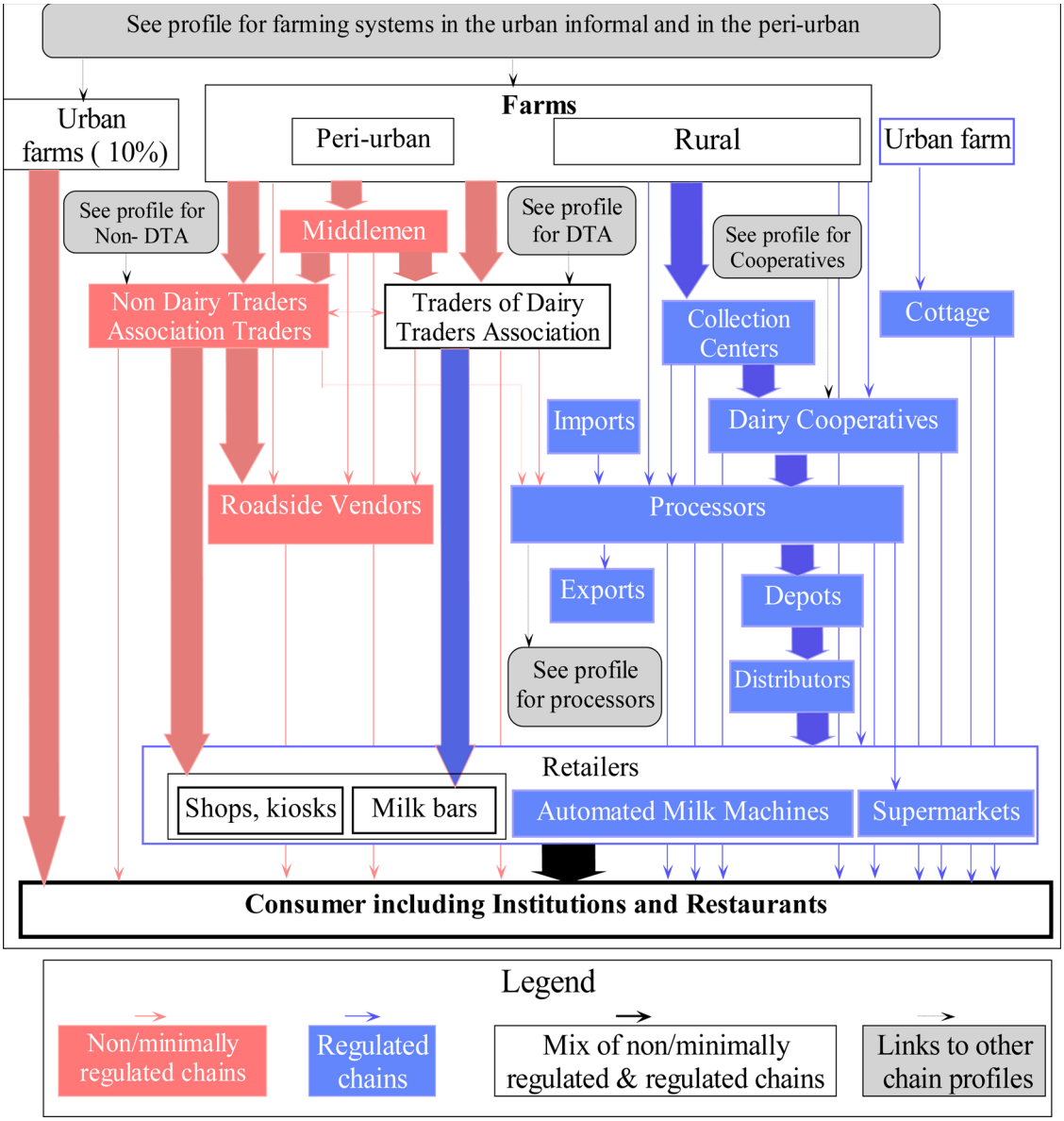

Fig. 1. Flow diagram indicating overall structure of the dairy food system operating in Nairobi. The figure identifies major chain segments (or chain profiles) composing the dairy system and differentiate between non/minimally regulated chains (informal– in red) and the regulated chains (formal – in blue). Source (Kiambi et al., 2018). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).

daily, about 841,000 full-time jobs are created at farm level and 15,000 jobs at processing level (FAO, 2011a). Further, the sector is a source of livelihood to more than 2.6 million people representing 80% of small-scale producers (KDB, 2014) and benefiting more than 80% of the people involved in informal milk trading (Leksmono et al., 2006).

The dairy value chains supplying Nairobi are characterized by fragmented structures, which resulted from liberalization of the dairy sector in the 1990s (Leksmono et al., 2006). Average milk consumption by city dwellers is generally high with poor households consuming approximately 1 L of milk per week (Cornelsen et al., 2016; James and Palmer, 2015). Rearing of dairy cows is not a major activity within Nairobi and over 90% of milk consumed in the city is supplied through value chains linked to production outside the city (Alarcon et al., 2017a). As a result, Nairobi's dairy value chain is characterized by complex interactions between a vast number of small-scale actors who mainly operate independently but are highly interconnected (Kiambi et al., 2018). Seven chain profiles (or system segments) constitute most of Nairobi's dairy value chain (Fig. 1). These chain profiles include: i) farming systems in urban informal settlement areas, ii) farming systems in peri-urban areas, iii) traders affiliated to the Dairy Traders Association (DTA), iv) traders not-affiliated to the DTA, v) medium-size dairy cooperatives, vi) large dairy cooperatives and vii) large processing companies. Each of the chain profiles links to another, thus forming the overall complex dairy food system. With increasing population growth, rapid urbanization coupled with unmatched demand and supply, the Nairobi dairy system will continue to evolve putting pressure on the existing value chains and triggering evolution of new chains, further complicating the already complex food system.

Several studies conducted in Kenya show the occurrence of various foodborne illnesses and presence of numerous hazards in milk. A study conducted to establish health hazards in milk under different marketing conditions found that up to 80% of samples did not meet the national bacterial quality standards (Omore et al., 2000). Furthermore, another study reported that for every 10,000 servings of unpasteurized milk consumed in Kenya, two to three cases of diarrheal disease result from common toxin-producing bacterium like *Escherichia coli* (Grace et al., 2008). In addition, high levels of aflatoxins M1 (Kagera et al., 2019; Kang'ethe and Lang'a, 2009; Kuboka et al., 2019), antibiotic residues

(Ondieki et al., 2017), antibiotic resistant bacteria (Ombui et al., 2000) and zoonotic disease causing agents like *Brucella abortus* and *Escherichia coli* 0157:H7 have been reported in both raw and pasteurized milk at farm and market levels (Kang'ethe et al., 2007b, 2000).

Efficient food safety control is strongly linked to the way food chains are organized and governed. The concept of governance describes the structure of interactions, power and coordination mechanisms existing between actors (Kaplinsky and Morris, 2000a). Several authors argue that interactions of actors within the systems are not just random, but are somehow organized (Gereffi, 1994; Gereffi et al., 2005; Kaplinsky and Morris, 2000b; Porter, 1998, 1980). Matters about who decides what is produced, why particular stakeholders interact, what type of rules exist (whether these are legislation, private standards or cultural norms), how these are enforced and codified (includes incentives, agreements and sanctions) and who are the rule makers in the system are all explained by value chain governance.

An understanding of how such chains are organized and coordinated is important in determining the point of entry to bring interventions that aim to improve or modify the chains (FAO, 2011b; Kaplinsky and Morris, 2000a). This is further emphasized by Michael Porter's concept on enhancing competitiveness for business models that aims at identifying the points of greatest force that would result in the greatest competitive advantage (Porter, 1985). This is because those involved at every level of the value chain need to see their importance and what they stand to ultimately gain to motivate optimal cooperation (Kaplinsky and Morris, 2000b). For example, Kenya milk trading is dominated by small-scale informal traders who control over 80% of all marketed milk (Leksmono et al., 2006). Informal systems are defined as enterprises that are not registered or licensed to operate and therefore are very difficult to regulate and monitor food safety hazards and risks (Delia and Roesel, 2014; Grace et al., 2010). Being aware of this, there have been attempts by the Kenyan government to organize the dairy system by training and certification of informal traders through a program dubbed, "formalization of the informal sector" (Alonso et al., 2018; Omore and Baker, 2009). Although food safety benefits are expected in such organized and well-regulated systems, a study documented by Kiambi et al. (2018) established that trained and certified traders affiliated to the DTA continued to operate with similar practices as the non-trained traders who were not affiliated to the DTA. In addition, the study reported that the number of traders adopting training and certification remained low, primarily due to the high cost of acquiring multiple licenses from different government agencies (Alonso et al., 2018). Such arrangements coupled with fragmented regulations have been reported to compromise efforts toward promoting food safety (Abebe et al., 2017; Gereffi and Lee, 2009). In Lebanon, for example, food safety issues have been described to be addressed by several legislative and regulatory decrees with overlapping functions (Abebe et al., 2017) and the food safety laws are termed as fragmented and limited in scope and scale to cover all parts of the food supply chain (Abebe et al., 2017; El-Jardali et al., 2014). Another study conducted in Vietnam found that relationships between farmers and milk collection points were mainly driven by proximity to milk collection centers located by roadsides for the large processing companies. The study found that societal connections were very influential in milk marketing such that social proximity was found to reduce uncertainties related to price, quality and quantity, and enabled access to informal credit, information and knowledge (Nguyen et al., 2017). This was particularly beneficial for farmers who were organized in hubs/groups, a model that was perceived to particularly benefit small-scale producers. In Kenya, a study implemented to support dairy smallholder commercialization found that although farmers were best suited to coordinate themselves horizontally (with other farmers), they were not necessarily best positioned to enhance vertical coordination (with other stakeholders) as they lacked such capacities (Kilelu et al., 2019). Farmers were observed to struggle with dilemmas such as inclusion, loyalty, trust and imbalanced power relations both among farmers and with other value chain actors. These studies suggest that successful coordination and governance of agri-food chains requires other intermediary arrangements that build on alliances between farmer organizations and other public or private organizations (Kilelu et al., 2019). However, such coordination is not always effective, especially in complex food systems and with multiple regulatory agents. These studies therefore generate important information on how analysis of governance enhances coordination to improve the robustness of a food system, but they lack the holistic analysis approach in respect to food safety.

The aim of the current study is to investigate the governance structure of Nairobi dairy value chain and its influence on food safety. Subsequently, this study builds on our previous report on mapping of dairy value chain in Nairobi (Kiambi et al., 2018) and provides policymakers, researchers and private stakeholders with relevant information for policy interventions to improve on the food safety system.

2. Methods

This cross-sectional study was implemented in Nairobi county, the capital city of Kenya between January 2014 and January 2015. The County, which lies on 696.1 km^2 of land is divided into nine administrative Sub-counties namely Westlands, Kasarani, Lang'ata, Embakasi, Starehe, Njiru, Makadara, Kamukunji and Dagoretti (Fig. 2). It lies between longitudes 36° 45′ East and latitudes 1° 18′ South at an altitude of 1798 m above sea level. The temperatures range between 10 °C and 29 °C while a bi-modal rainfall pattern is experienced usually with an annual mean of approximately 786.5 mm. Nairobi, the largest city in Kenya represents 9.2% of the country's human population. The population has grown by 45% from 3.1 million people in 2009 (KNBS, 2010) to 4.4 million in 2019 (KNBS, 2019). This means an increase of 130,000 people on average per year translating to an annual growth rate of 4.1% which agrees with previous prediction for urban growth rate in Africa placed at approximately 4% (Aubry et al., 2010). Based on the current population and Aubry's projection, Nairobi is predicted to have a total human population of about 10.3 million by the year 2050. This rapid population growth is expected to create a lot of pressure to produce and supply more food for the city dwellers which may trigger evolution of more complex food chains which may as well present challenges with food safety standards. In order to understand the governance structure and associated challenges within the Nairobi dairy system, initial framework developed by Kiambi et al. (2018) identified seven profiles/chain segments (Fig. 1) onto which the current study was overlaid (Kiambi et al., 2018). Three research questions were examined: i) What are the governance challenges experienced by different actors in the chains? ii) What are the main governance factors that explain stakeholders' interactions and chain behavior? and iii) What are the food safety implications that can be derived from the challenges and governance factors identified?

2.1. Selection of study participants

As a first step, a desktop review was done to identify the main organizations and people involved in the Nairobi dairy value chain in order to determine the process of data collection. Subsequently, key informant interviews (KIIs) with relevant senior staff at the Directorate of Veterinary Services (DVS), Directorate of Livestock Production and the Kenya Dairy Board (KDB) were conducted to complete and validate the list of stakeholders to interview, and to provide initial understanding of the governance in the system.

From the scoping visits, important segments of the value chain were identified for detailed data collection, including dairy farmers (urban and peri-urban), traders (DTA and non-DTA), bulking centers (collection centers, dairy cooperatives), large milk processors and public officers. The latter includes KDB officers in charge of licensing, city council officers, livestock production officers (LPOs) and public health officers (PHOs). In total, 22 focus group discussions (FGDs) with 116

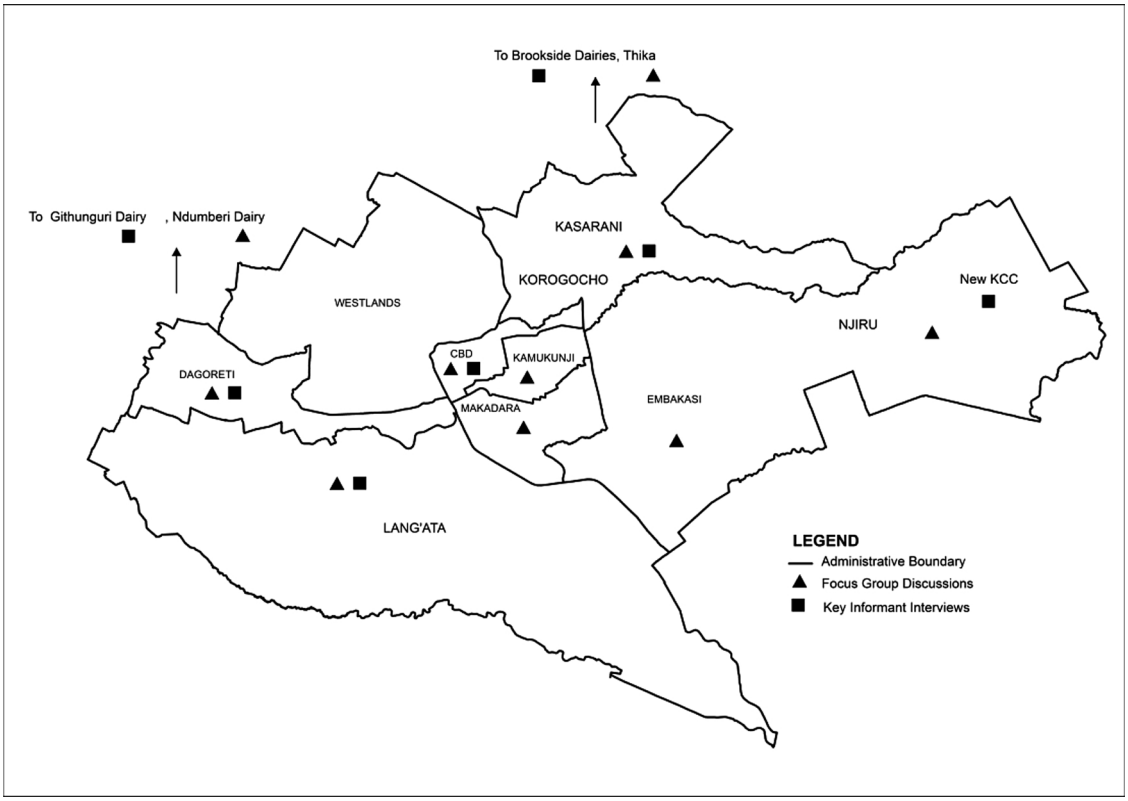

Fig. 2. Map of Nairobi County showing the study sites and type of interviews that were done.

people and 15 KIIs with 19 people were conducted at various nodes of Nairobi's dairy value chain (Table 1). When possible, interviews were done with representatives of associations or institutions (e.g. DTA) or senior managers in charge of enterprises (e.g. dairy cooperatives or large processors).

2.2. Data collection by interviews

Interview guides were used to gather data from the FGDs and KIIs. These were tailored for each FGD and KII based on participants' type of activities (production, bulking, processing, regulation etc.) but the structure maintained a similar pattern of questions. Data were video audio recorded when possible and a minimum of two research assistants recorded the discussions in notebooks.

In each FGD, a local person who understood the local language (s) was identified to clarify words or statements unclear to the group. Participants were allowed to brainstorm on each question until there was consensus on the issue under discussion. Prompts such as 'why' and 'how' were used to stimulate participants for detailed discussions on important arguments. Participants were asked to describe:

1) Their enterprise and operations. For example, for dairy farmers, efforts were made to understand farm management practices (feeding, breeding, animal health services, selling of milk); traders were asked to describe patterns for milk sourcing, products they deal with, value addition and selling patterns, among others.
2) Their interactions. For each of the interactions mentioned (with buyers/sellers/associations/government) participants were asked to:
   a Describe their affiliations or lack of affiliations to any associations or power groups (participants were prompted to give reasons for being or not being in such groups).
   b Describe how a deal is made and the types of agreements made (e.g. written contract, verbal agreement etc.).
   c List the types of incentives for dealing with the said people or organizations.
   d List the types of agreements, rules and regulations they had to follow (legislative, private standards etc.).
   e List the types of sanctions/penalties experienced for not adhering to such agreements.
   f Describe the challenges they faced within interactions.
3) Explain how their perceptions and practices influenced milk quality and safety. Probing was used to understand:
   a Practices at production, collection/bulking, processing and transportation.
   b Influence of regulation and private standards.

A similar approach was used for each of the key informants but with the addition of describing their role in influencing the chain. Some examples of the questionnaires used for this study are provided in the supplementary material.

2.3. Data analysis

The voice and video recordings were carefully listened to and all the information was collated into pre-formatted templates (i.e. Word documents organized to enter qualitative data in distinct sections based on predefined categories such as interactions, incentives, food safety etc.). Data entry was complemented with data collected in notebooks and on the flip charts created with participants during the FGDs and KIIs.

Thematic qualitative analysis was performed to identify emerging themes that provided an understanding of a challenge incurred by value chain stakeholders, a governance factor or an associated food safety factor. Themes were categorized by type of stakeholder: urban (informal settlement) and peri-urban farmers, DTA trader, non-DTA trader, retailers, dairy cooperatives, large processing companies and the different types of public regulators (as established by Kiambi et al. (2018)).

Table 1
FGDs and KIIs conducted across the Nairobi value chain in 2014–2015.

Chain node/Functions	People working in the chains	Activity	No. of FGDs (no. of people)	No. of KIIs (no. of people)
Production	Dairy cow farmers in urban informal settlements (Kibera)	Milk production, selling of milk	1 (10)	–
	Dairy cow farmers in peri-urban areas (Dagoretti and Kikuyu)	Milk production, selling of milk	2 (14)	–
	Dairy cooperatives (medium and large scale)	Milk assembly, bulking, cooling and transport of raw milk, extension services and inputs, offer credit facilities and soft loans to producers	1 (7)	1 (1)
Milk collection and selling	Traders affiliated with the DTA	Extension and inputs, milk assembly, bulking and transport of raw milk, lobbying for policies	–	3 (3)
	Traders not affiliated with the DTA	Milk assembly, bulking and transport of raw milk	3 (19)	–
	Dairy cooperatives	Milk assembly, bulking, cooling and transport of raw milk, extension services and inputs, offer credit facilities and soft loans to producers	1 (7)	1 (1)
Processing	Two large milk processing companies based in Nairobi (interviews done with managers of the companies)	Extension services, milk assembly, bulking, cooling and transport of raw milk, milk processing, value addition and distribution of processed milk products	–	6 (8)
Retailing	Supermarkets, milk bars, restaurants, milk vending machines, roadside vendors, shops and kiosks	Processed and raw milk outlets, direct milk sales to consumers	2 (13)	2 (2)
People supporting and influencing the chains	KDB	Set standards, inspect and license dairy enterprises, regulate dairy industry and facilitate trade	2 (8)	2 (4)
	City council of Nairobi	License businesses	1 (7)	–
	PHOs	Enforce public health laws to ensure food safety and management of public health through inspections, e.g. of food and non-food premises	2 (10)	–
Service providers/influencers	LPOs	Provision of extension services (e.g. advice on animal management, housing etc.)	7 (21)	–
Total			22 (116)	15 (19)

A theme was considered a challenge when it represented a barrier to entry or upgrade, or for efficient or safe completion of an activity. A theme was considered related to governance if it involved interaction of stakeholders, structural organization of power groups, chain dominance, rule setting and/or following (private standards, legislation or other norms), types of agreements and rule enforcement (including sanctions and penalties). Themes that could be categorized as both a challenge and related to governance were placed in the governance section (e.g. a power group imposing a barrier to a stakeholder). Food safety implications were then derived from participants' explanations of how governance and challenges impact food safety behavior, or through authors' deductions on resulting themes.

3. Results

3.1. Dairy farmers

3.1.1. Farmers' challenges

Seven challenges were identified among all groups (Table 2). All farmer groups described problems with artificial insemination (AI) services that often failed due to untimely heat detection by famers or unskilled AI providers, increasing the need for repeat insemination. These AI providers were perceived to be money driven rather than by professionalism. Animal feeds was also a challenge reported in the three groups, as often they were insufficiently available, costly and of low quality, particularly the commercially acquired hay and concentrates. Some farmers had to use unorthodox sourcing of feeds, such as leftovers from markets or dumpsites, and green pastures growing by sewer lines (farmers in informal settlement areas) and by the roadside (peri-urban farmers). Diminishing land size necessary for cultivation of fodder and extension of herds was listed as the main reason for these issues, with land size changes driven by growing urbanization and property developments like real estates. This poor reproduction efficiency and high cost of inputs were stated as the reasons for a perceived lack of profits, which was worsened by their frustration in accessing credit and loan facilities to boost their dairy enterprises. Farmers reported mostly to rely on other farmers to access any information related to dairy farming. Farmers in informal settlements reported that they mostly rely on unqualified persons and self-treatment of their livestock.

3.1.2. Governance themes associated with dairy farmers and implications for food safety

The governance themes identified by farmers and their implications for food safety are presented in Table 3. Several themes pointed to a general self-reliance by farmers due to insufficient access to government support and lack of capacity to receive training due to lack of associations in informal settlement areas or low membership in dairy cooperatives in peri-urban areas. Farmers said there was a ready milk market and therefore felt no need for associations, while others mentioned that the incentives for dairy cooperative affiliation was to access credit facilities or services (animal feeds, AI and health services, soft loans). Whereas farmers affiliated to dairy cooperatives received some training and extensions services, those in informal settlement areas reported fear of sanctions (arrest, jail, confiscation of livestock) for keeping livestock in the city which was seen as being outlawed; this explained why they could not attend any training organized by government. It was perceived that farmers' preferred selling milk to hawkers or traders (rather than cooperatives) for quick cash and better prices and that it was easy to switch traders who refused to compromise on milk quality (adulteration). Furthermore, farmers reported a lack of contracts with traders. While farmers did not perceive that milk was controlled by any power group, feed price was however seen to be controlled by just a few companies, which increases the cost of production and the need to access alternative informal low-quality feeds.

Table 2
Challenges reported by farmers in Dagoretti and Kikuyu (peri-urban areas) and Kibera (urban informal settlement area).

	Peri-urban		Informal settlement	Potential key food safety Implications (*authors' view)
	Dagoretti	Kikuyu	Kibera	
Losses associated with poor heat detection and repeat inseminations due to unskilled AI providers	✓	✓	✓	*Poor efficiency implies less profits and reduced capacity to upgrade farm
High cost and low-quality feeds	✓	✓	✓	Possible use of contaminated feeds, increased vulnerability to diseases
Low production, high cost of inputs and difficult to make profits	✓	✓	✓	*Lack of capacity to upgrade farm and improve food safety management
Competition for animal feed, but not for milk market	✓	✓	✓	*Possible use of contaminated feeds, increased vulnerability to diseases
Lack of training on food safety and insufficient extension services	✓	✓	✓	*Reduced capacity to control foodborne zoonosis and implement good practices. Scarcity of extension services and high cost of private animal health services results in the use of untrained and unqualified persons for management of animal diseases
Unable to access training offered by dairy coops as only for members	✓	✓		*Food safety information is dependent upon farm-to-farm knowledge transfer, which may not be informed by best practices
Difficult to access loans (capital, medicine, AI and feed)	✓	✓	✓	*Lack of capacity to upgrade farm to improve food safety management
Diminishing land for dairy (real estate development)	✓	✓	✓	*Potential for increased transmission of disease and contamination of products
Lack of enough milk for value addition	✓			
Animal diseases e.g. mastitis, East Coast Fever, helminthiasis, pneumonia in calves		✓		*Possible contamination and transmission of foodborne and zoonotic diseases
Expensive and ineffective treatments			✓	*Reduced capacity to control foodborne zoonosis
Feeling of being prohibited access to training and animal health services (lack of business legitimacy)			✓	*Reduced capacity to control foodborne zoonosis and implement good practices
Difficult to find and keep workers (farming perceived as rural jobs)	✓		✓	*May reduce motivation of workers to follow good practices

3.2. Traders and retailers

3.2.1. Challenges associated with traders and retailers

The list of challenges reported by DTA, non-DTA and retailers are shown in Table 4. A common theme for all groups was the perceived inability to obtain the multiple, costly and cumbersome licenses required by KDB and city council. For example, Table 5 shows the basic requirements necessary to operate a retail milk bar. Besides stringent specifications for premises (tiled walls, cemented floors, running water etc.), approximately Kenya shillings 18,100 – 42,200 (USD 180–420) is required to purchase licenses/permits for milk retailing at a milk bar. This amount is excluding daily cess (type of revenue that is paid to KDB on every liter of milk handled per month). Apart from a few DTA traders who operate with a few licenses, most of the traders and retailers reported operating without any required licenses. Consequently, corruption and harassment of non-DTA and retailers were cited as a big challenge. For example, non-DTA traders reported that during the wet season, city council officers poured their milk out and arraigned the trader in a court of law where they were fined or jailed. During the dry season, traders reported that the officers would confiscate their milk and did not arraign them in court.

Non-DTA traders and retailers reported challenges in sourcing milk from multiple farmers due to low productivity per farm, hence they lost valuable business time roaming from farm to another. Additionally, non-DTA traders complained of KDB's demand for aluminum containers for milk transportation which they described as being heavy, difficult to carry in public service vehicles and associated with losses due to spillage. Consequently, they reported use of non-food grade plastic containers. While some traders reported cleaning the containers with hot water and soap, they said some traders used other preservation methods like addition of formalin and hydrogen peroxide to minimize spoilage while transporting milk over long distances without a cold chain.

For DTA members, the main challenge mentioned relates to the extremely low membership in their association, which deflates their efforts to negotiate for better regulation and marketing terms. They were also unable to sell to institutions because the law prohibits sale of unpasteurized milk to consumers, yet the cost of setting up pasteurization units was unaffordable. Their attempt to obtain pasteurization services at a small fee by the large processing companies was futile; they cited unending fights between large processors and DTA who were seen to compete unfairly, since they were perceived to require less capital and smaller business running costs than large processors.

3.2.2. Governance themes associated with dairy traders and retailers and implications on food safety

Governance themes identified by traders and retailers are provided in Table 3. Registration with DTA requires traders to pay a certain fee and undergo training by specific KDB-accredited business development service providers on milk handling, hygiene, bookkeeping, business ethics and value addition. The majority of traders were not affiliated with DTA, which was reported to be due to unwillingness to pay for this training citing its high cost, the ability to sell and make profits without the training, the perception that farmers and consumers did not require traders be trained to buy/sell milk, the difficulties in adhering to rules set by DTA and KDB (high milk standards and multiple licenses) and lack of protection by government from unfair competition with untrained non-DTA traders. This was perceived as a reduction in the capacity to negotiate or influence the chain. For instance, traders perceived that the access to institutions and high-end markets was also hindered by the large processing companies, who quoted exorbitant charges for pasteurization services. This was seen as an ability to rapidly influence milk prices in the market. This generates a negative perception of traders for these companies. On the other hand, non-DTA traders and retailers reported it was easy to start a milk business, but it required one to be strategic to evade licenses and regulation. They

Table 3
Governance themes identified by farmers, traders and retailers in the dairy value chains.

Node	Governance themes	Food safety implications (*author's view)
Farmers	Lack of farmers' associations (urban informal area); low membership to cooperatives in peri-urban areas (All farmers)	*Lack of associations and fear of government prevents access to food safety training
	Farmers learn from each other, rare interaction with government (Farmers, cooperatives, LPOs)	*Low cost of switching to hawkers and ready market implies traders have low power to sanction farmers based on food safety and increased risk of unsafe milk sold
	Prefer selling to hawkers - better price and pay cash on delivery (Farmers in peri urban)	*Control of feed prices by few companies generates lack of access to quality feeds for some farmers, who then shift to informal sources with low quality. This may lead to cross-contamination and disease vulnerability
	Lack of formal contracts but operates on trust (All farmers, traders, retailers)	*Pressure to avoid financial losses nudges some farmers to not observe withdrawal period or to dispose of unsuitable milk
	Low cost of switching to other hawkers (easy to switch traders) (Farmers in peri urban)	
	Women more involved at production, but men decide on selling of cows (Farmers in peri urban)	
	Consumer preference to buy milk directly from farmers (All farmers)	
	Few feed companies control feed prices (Dairy cooperatives)	
	Financial pressure not to dispose of milk during treatment for disease (All farmers)	
	Farmers are responsible for maintenance of some milk collection centers (Farmers in peri urban)	
Traders and retailers	Do not see added value for training since they can still make profits (DTA and non−DTA traders)	*Traders not part of DTA do not have access to food safety training provided by the association
	Difficulty to adhere to KDB rules and DTA code of ethics (DTA traders and retailers)	*Traders not willing to pay for training- lack of incentives
	Target low income people because they demand cheaper prices (DTA traders and retailers)	*Lack of access to pasteurization services reverts to selling of raw milk to consumers
	Unable to sell to institutions - law restrict selling of raw milk (DTA and non−DTA traders)	*Trained traders can profit from value addition knowledge and avoid use of unsuitable milk
	Exorbitant pasteurization fee by the large processing companies (DTA traders)	*Cost of multiple licenses incentivizes operation without medical certificate and avoidance of food safety regulations
	Easy to start business, if not paying license (DTA, non−DTA traders and retailers)	*Lack of food safety control of milk during transportation (based on trust)
	Unlicensed businesses located far from main roads to escape regulation (non−DTA traders)	*The pressure to avoid financial losses nudges traders to convert spoiled milked into fermented milk or yoghurt
	Lack of contract and operates on trust (DTA and non−DTA traders)	*Large processing companies provide traders with hydrogen peroxide to conserve milk during long distance transportation without cold chain. This reduces incentive for traders and farmers to observe hygienic practices
	Farmers decide on mode of payment by traders (DTA, non−DTA traders and retailers)	
	Negative perception of traders by large processing companies (DTA and non−DTA traders)	
	Women dominate dairy business in informal settlements (non−DTA traders)	
	Area chiefs resolve disputes of rejected milk (non−DTA traders)	
	Non-DTA have strong social networks for milk selling and support in crisis (non−DTA traders)	
	Prefer to sell raw to avoid extra cost and sell at cheaper prices (DTA and non−DTA traders)	
	New hawkers work under existing hawkers to gain trust (DTA and non−DTA traders)	
	Pressure of rejecting milk due to lack of supply (DTA, non−DTA traders and retailers)	

The people in brackets is the type of stakeholder who said that in the interview.

reported the existence of strong social networks that supported them in milk sourcing and selling, and to bail out when arrested.

All the groups reported that they targeted low-income consumers and low incentive to reject unsuitable milk due to insufficient supply and added value to spoiled milk (fermented or yoghurt). Traders reported that some large processing companies provided farmers and traders with hydrogen peroxide (in tablet form) to add into milk to prevent spoilage during long distance transport when they had no cold chain facilities.

3.3. Dairy cooperatives and large processing companies

3.3.1. Challenges associated with dairy cooperatives and large processing companies

Challenges associated with dairy cooperatives and large processing companies are provided in Table 6. Lack of coolers was reported as a big challenge by cooperatives due to high cost of installation and maintenance. This was reiterated by the large processors who in addition cited low milk volumes in the country as a major disincentive for such investments. Cooperatives and large processors reiterated their frustration regarding frequent milk rejections which they complained promotes unfair competition especially with the informal sector. Despite internal guidelines regarding milk quality, sometimes they were forced by circumstances to accept milk of lower quality. This was attributed to low farm production of milk which led to increased competition with the informal sector, who were perceived to not care much about milk quality. It was reported that there were no policies for management or disposal of the rejected or spoiled milk, other than giving it back to the supplier. Rejected milk was therefore reported to be sold for pigs (cooperatives and large processors) or converted to home-made yoghurt or sold as *'mala'* (traditionally fermented milk) by farmers, traders and retailers. Additionally, cooperatives and large processors echoed their frustrations with lack of adequate infrastructure citing the poor road network in production areas and lack of physical

Table 4
Challenges associated with dairy traders and retailers.

	DTA	Non-DTA	Retailers	Food safety implications (*authors' view)
Must source milk from many farms because of low production per farm		✓	✓	*Reduced capacity to establish contract and, hence, food safety agreements with suppliers
Competition for sourcing, not for selling milk	✓	✓		*Reduced power to establish private standards on food safety
Aluminum containers unsuitable because they are heavy, cause spillage and difficult to carry		✓		Use of plastic containers that are difficult to clean
High cost of business development training before entry into DTA	✓			*Reduced food safety knowledge and good practice by non-DTA
Too many rules and multiple licenses required by KDB and city council	✓	✓	✓	*Increase of illegal business difficult to regulate and enforce
High business rent and standards in high-end market	✓			*Increased use of food safety practices in high-end markets
Lack of access to institutions (since they sell raw milk)	✓			*Milk safety control by institutions
Lack of capital to establish pasteurization unit	✓			Selling of raw milk
Lack of access to pasteurization services (from processors)	✓			Selling of raw milk
Lack of capital to buy food grade containers recommended by KDB	✓			Use of plastic containers that are difficult to clean
Harassment by city council/KDB due to lack of licenses and medical certificate		✓	✓	*Reduced cooperation to follow food safety practices
Corruption from city council (they bribe often to continue with trading)		✓	✓	*Reduced incentive to implement food safety practices
Insecurity because they operate very early hours (from 2 am)		✓		*Escape regulation
Emerging threat of milk vending machines (consumers prefer buying from these machines)			✓	*Perception of increased food safety and quality in milk vending machines
Lack of training and knowledge			✓	*Reduced food safety knowledge and good practices
Low membership in DTA (only 2203 of the total 56,446 traders are active members; of the active members, 40% are in Nairobi)	✓			*Reduced use of training and power to improve standards in the system

Table 5
Requirements for running a retail milk bar.

	Description	Source	Cost (*K Sh.)	Valid
Application fee	Application fees to KDB	KDB	600	One off
Recommendation letter	From KDB-certified milk supplier	Supplier	No charge	
KDB license	Certify milk business by the KDB	KDB	2500	1 year
Business medical certificate	Certifies premise as a food kiosk	City council	5000	1 year
Single business permit	To be allowed to trade in the city	City council	5000 – 5500	1 year
Medical check-up employees	Medical check-up of employee before award of medical certificate	Government health facility	400 – 1000	1 year
Fire extinguisher inspection fee	To verify fire extinguisher has been installed at the business facility	City council	1000	1 year
Carriage (permit)	Transport/movement permit	KDB	1600	1 year
Garbage collection fee	City council garbage collection	City council	2000–25,000	1 year
**Cess fee	Per liter of milk traded	KDB	0.4/liter	Monthly
Total			18,100 – 42,200 per year (excluding cess)	

*Kenya shilling 100, approximately USD 1.
**Cess fee is a type of tax levied by the KDB for every liter of milk traded (source: http://www.kdb.go.ke/licensing-procedures/).

sheds for milk collection (milk collected by roadsides). Apart from the high cost linked to milk collection from many farmers/collection centers, breakdown of vehicles and thereby delayed delivery of milk to destinations was identified as a major challenge associated with high levels of milk contamination and spoilage.

3.3.2. Governance themes associated with dairy cooperatives and large processing companies and implications on food safety

Table 7 displays the governance themes associated with dairy cooperatives and large processing companies. Both groups suggested that a milk trading environment exists that displays unfair competition. They reported that: i) the government failed to regulate the informal sector while overregulating the formal chains (cooperatives and processors), ii) the KDB had started formalizing traders through training and registration (DTA), iii) they lacked support in infrastructure development associated with high costs of milk collection from farms, iv) with devolved system of governance, several counties (subnational) were setting up dairy plants (further reducing milk that they received from rural areas), v) inability to compete with traders on pricing since traders had minimal operating costs and vi) it was a struggle to reject milk since it would be accepted elsewhere (lack of policies for management of rejected milk). This unfair competition was believed to generate a lack of effective monitoring and reduced the incentive to comply with food safety regulations along the value chains. Several positive incentives were mentioned that may influence farmers to join and supply the dairy cooperatives and large processing companies. These were financial, through improved access to credit or better payment, and technical, through provision of services (e.g. animal health) or access to training. On the other hand, sanctions were in place to reduce milk rejections (especially through bad practices, such as milk adulteration) and to incentivize farmers to avoid selling milk to independent traders. This contrasted with the perception that dairy cooperatives are unwilling to pay for milk quality, reducing the incentive for farmers to improve.

3.4. Government officers

These include the KDB, PHOs, LPOs and city council officers. The role of KDB is regulation of the dairy sector through enforcement of the Dairy Industry Act CAP 366. The board is responsible for inspection and licensing of milk handling premises and surveillance on quality and safety of milk and milk products along the dairy value chain. The Nairobi city council is responsible for licensing of businesses. They provide single business permits, business medical certificates, employees' medical certificates, inspect installation of fire extinguishers at business premises and facilitate garbage collection. The responsibility of PHOs was reported to be food and sanitary inspection of premises, offering of medical certificates and enforcing public health-related laws like Public Health Act, CAP 242, Drugs and Chemical Substance Act, CAP 254, Meat Control Act, CAP 354 and regulation of food related city

Table 6
Challenges associated with dairy cooperatives and large processing companies.

	Dairy cooperatives	Large processing companies	Food safety implications (*authors' view)
Farmers reluctant to learn from free training	✓		*Reduced knowledge and good practices
Farm owners not attending training (they send attendants)	✓		*Lack of knowledge transfer to the person who has power to enforce
Production losses due to poor heat detection by farmers	✓		*Poor efficiency implies less profits and reduced capacity to upgrade business
Low milk supply in dry seasons	✓	✓	*Poor efficiency implies less profits and reduced capacity to upgrade business
Lack of breeding expertise by extension officers	✓		*Poor efficiency implies less profits and reduced capacity to upgrade business
Low number of active members with most selling to traders because they pay cash	✓		*Use of less regulated channels
Lack of enough coolers at bulking centers	✓		*Risk of milk spoilage
Low milk volumes to warrant installation of coolers or key infrastructure	✓	✓	*Lack of cold chain increases risk of milk spoilage
High milk rejection from small-scale farmers	✓		*High volumes of rejected milk increases pressure to recirculate
High cost and poor quality of inputs discourage productivity	✓	✓	*Poor efficiency implies less profits and reduced capacity to upgrade business
High cost of multiple licenses	✓	✓	*Increase of illegal business difficult to regulate and enforce
Over taxation and double payment of cess		✓	*Increase of illegal business difficult to regulate and enforce
Poor roads and public infrastructure	✓	✓	*Increased risk of milk spoilage
High prevalence of animal diseases	✓	✓	*Risk of milk contamination
Struggle to reject unsuitable milk (low supply, competitors)	✓	✓	*Risk of unsafe milk entering the food chain
Lack of procedures for management of rejected milk	✓	✓	*Risk of unsafe milk entering the food chain
Shortage of staff to provide extension services	✓		*Reduced food safety knowledge and good practices
Operating at half capacity due to unstable markets and machine maintenance challenges		✓	
Lack of enforcement of standards across the value chain		✓	*Reduced incentives to follow food safety practices

by-laws. The responsibility of LPOs was reported to be advising farmers on production through extension, monitoring of disease outbreak rumors, advice on appropriate housing structures and dimensions for livestock, dissemination of information, creating linkages with markets, organizing farmer field days and training of farmers.

3.4.1. Challenges associated with government officers

Challenges reported by KDB, PHOs, LPOs, and city council officers are reported in Table 8. Hawkers (mobile traders) were described as the most difficult people to control and regulate; and they were perceived to adulterate milk through addition of margarine (to deceive consumers on high butter fat content), water (to increase volumes), antibiotics (for preservation) and flour (to deceive consumer on milk thickness). Hawkers were also perceived to ignore milk hygiene since their lower milk prices compel consumers to buy from them.

Another challenge reported was the lack of medical certificates, which was attributed to the high cost and frequency of obtaining them. For example, it was reported that a medical certificate is required to be renewed every six months. Officers felt that some retailers were not comfortable with the lack of clarity on the type of test needed to obtain the medical certificate, with many of them fearing being tested for HIV status. Inadequate water supply was also cited as a major problem. It was said that those people without water rarely mopped their premises and instead only swept their floors. Furthermore, the origin of water used for cleaning utensils was of questionable quality since it was supplied by cart pullers. Inadequate water problems were further complicated by poor infrastructure (semi-permanent buildings in area), especially in the informal settlement areas which were located near open sewage trenches. Another challenge was related to lack of cold storage facilities; which was due to power breakdowns in supermarkets in informal and peri-urban areas.

Lack of an adequate workforce was reported as a significant hindrance to effective performance by the dairy system. For example, it was reported that there were very few government officers employed to serve at various levels of the system from production (few extension services by LPOs) and there was an inadequate number of staff to effectively undertake monitoring, regulation and enforcement (KDB, PHOs, city council).

3.4.2. Governance themes associated with governance officers and their implication on food safety

Table 9 reports governance themes identified by KDB, PHOs, LPOs and city council officers. Lack of premises by mobile traders and retailers made monitoring, regulation, training and application of sanctions difficult. Due to this, the city council deployed a team of field officers to collect daily cess and to identify retailers/traders operating illegally without a premise, as required by law. Political interference was cited as a big challenge in enforcement of laws. Attempts to close uncompliant businesses met with interference by politicians who want to be seen as the voice of people (city council, PHOs).

4. Discussion

This study investigated governance and challenges associated with food safety in the complex dairy value chain of Kenya's largest urban setting. The value chain framework previously developed by Kiambi et al. (2018) was utilized to overlay governance and challenges themes to facilitate interpretation and clarity of results. It is agreed that complex food systems require strategic analytical approaches to determine critical points for intervention and several studies have described how such analysis can be achieved (Alarcon et al., 2017b; FAO, 2011b; Muloi et al., 2018; Onono et al., 2018). It is important to note that the food safety concerns identified in this study represent stakeholders' views and authors' inference of the results. The extent to which these concerns can cause high levels of food safety hazards requires further validation, especially through risk assessment and microbiological procedures. A detailed analysis of these risks was beyond the scope of this study, as this study was focused on understanding the role of

Table 7
Governance themes identified by dairy cooperatives and large processing companies in the dairy value chains.

Governance themes from dairy cooperatives and large processing companies	Food safety implications (*authors' view)
Unfair competition	Cooperatives provided access to food safety training to farmers
Failure to regulate traders and overregulation of formal chains (large processing companies)	Lack of clear protocol nudges farmers to resell rejected milk
Licensing of traders (formalization of informal sector) (large processing companies)	Private standards implemented to ensure hygiene (e.g. use of adequate aluminum containers, ISO certified, HACCP procedures)
Inability to compete with traders on pricing and cost of production (large processing companies)	Organoleptic tests done at collection centers and microbiological analysis at processing centers to ensure quality control
Lack of support on infrastructure development (large processing companies and dairy cooperatives)	Control mechanism to diagnose cases of recurrent spoilage
It is a struggle to reject milk (large processing companies and dairy cooperatives)	Incentive to reduce rejections though loss of bonuses
Devolution system of governance seen as threat with most counties installing processing plants (large processing companies)	Access to cheaper loans may incentivize food safety upgrade of farms
Positive incentives	Cooperatives provide access to private veterinarians and other animal health services
Credit access to feed, AI and animal health services and household items (but feed more expensive) (dairy cooperatives)	*Hawkers are more likely to receive unsuitable milk from farmers
–Cooperatives provide loans at lower interest rate to members (dairy cooperatives)	Processing companies feel that the greatest challenges to the quality of milk comes from small and medium suppliers
–Provide internal training to members only (dairy cooperatives)	*Long distance vehicles with lack of cooling system may be more susceptible to milk spoilage/adulteration
–Bonus provided on amount of milk delivered and profits (large processing companies and dairy cooperatives)	Monitoring storage post-marketing ensures minimal spoilage and overstocking of milk by retailers
–Cooperatives test milk samples from farms with recurrent spoilage events (large dairy cooperatives)	
–Long-term suppliers paid first by processing companies in times of financial crisis (large processing companies)	
–Large processing companies assure a constant price to long-term suppliers (large processing companies)	
–Large processing companies pay based on volume band system (large processing companies)	
–Large processing companies recommend farmers to financial institutions for loans (large processing companies)	
Sanctions	
–Farmers are forbidden to sell milk to hawkers or adulterate milk, and incur heavy sanctions if discovered (large dairy cooperatives)	
–Milk rejections are sanctions though loss of bonuses (large processing companies and dairy cooperatives)	
–Farmers and traders bear the cost of milk rejections (including termination of contracts) (large processing companies)	
Others	
–Cooperatives not willing to pay for quality (large dairy cooperatives)	
–High private standards (need to follow a lot of internal rules) (large processing companies)	
–Feel that government should develop a national protocol for the use/ disposal of rejected milk so that it doesn't flow back to consumers (large processing companies)	
–Payment to suppliers done monthly post-delivery (large processing companies and dairy cooperatives)	
–Farmers registered in cooperatives without written contract (dairy cooperatives)	
–Large processing companies test milk delivered by cooperatives (large processing companies)	
–Offer AI service to non-members, but paid in cash but members are deducted from milk sales at the end of the month (dairy cooperatives)	
–Members must own a cow (s) to be allowed as a member, to avoid recruiting hawkers (dairy cooperatives)	
–There is lack of control or monitoring of milk during transit (large processing companies)	
–Provide training to extension agents to ensure quality (large processing companies)	
–Large processing companies have written contract with most suppliers (large processing companies)	
–Large processing companies monitor storage by some clients post-marketing (large processing companies)	

governance in the creation of risks. It is clear, however, that tackling the complex governance structure in the milk system, and in particular the many interactions between parallel value chains, has several downstream impacts on potential disease risks and the subsequent food-borne disease burden in human consumers.

At production, farmers reported a general lack of or inadequate support by the both the public and private sectors. This is characterized by insufficient training and extension services coupled with lack of incentives in the system. Farmers felt there was a lack of an enabling environment to promote dairy enterprises, in particular when faced with a high prevalence of animal diseases, high cost and low-quality animal feeds, diminishing land for expansion of dairy (blooming of real estate) and the lack of credit and loan facilities. This perhaps reflects the national image of the dairy industry post liberalization in 1991 (MALF, 2013, 2010; Rademaker et al., 2016). Government divestiture of the Kenya Cream Creameries which resulted in privatization of services such AI, tick control and veterinary clinical services caused a general decline in performance of the dairy sector (MALF, 2013). Food safety implications associated with these challenges are related to widespread lack of extension services and training, suggesting that milk production practices and attention to food safety is dependent upon the source of information (whether good or bad). Various studies have explored diseases and other public health hazards in milk (Grace et al., 2008; Kang'ethe et al., 2007a; Kang'ethe and Lang'a, 2009; Ombui et al., 2000; Omore et al., 2000, 2002; Ondieki et al., 2017). A detailed analysis of these risks is beyond the scope of this study, but several of the hazards identified in those studies stem from the governance issues discussed in the present work. It is clear that tackling the complex governance structure in the milk system, and in particular the many interactions between parallel value chains, has several downstream impacts on disease risk and the subsequent food-borne disease burden in human consumers.

The main challenges and governance issues associated with traders and retailers were harassment by KDB, city council and PHOs for lack of required licenses and permits due to the associated costs and cumbersomeness of obtaining them. While the laws, policies, licenses, permits and standards are meant to streamline coordination and bring order along the value chain, this has not been the case for Nairobi's dairy value chain. These findings are consistent with previous analyses that cited inappropriate regulations as a major factor constraining development of enterprises particularly in developing countries (Alonso et al., 2018; Pfeffermann, 2001). In an attempt to organize informal milk trading in Kenya, KDB established a training and certification model that enabled formalization of the informal traders (Roesel and

Table 8
Challenges associated with government officers.

	KDB	PHOs	City council officers	LPOs	Food safety implications (*authors' view)
Milk hawkers pose biggest challenge to control	✓	✓	✓		Escape regulation and monitoring of food safety hazards
Lack of licenses and medical certificates	✓	✓	✓		Increase of illegal business difficult to regulate and enforce
Inadequate water supply	✓	✓	✓		*Risk of unsuitable food safety practices
Lack of cold storage facilities	✓	✓	✓		*Lack of cold chain increases risk of milk spoilage
Long distance transportation without cold chain	✓	✓	✓		*Lack of cold chain increases risk of milk spoilage
Inadequate staff to enforce regulations	✓	✓	✓	✓	Reduced efficiency to monitor and enforce food safety regulations
Lack of office vehicles to facilitate license issuing; employees must walk to premises			✓		*Poor efficiency implies reduced capacity to regulate the system
Inappropriate milk handling (non-food grade containers)	✓	✓		✓	*Risk of milk contamination and spoilage
Cost of food-grade containers four times higher than plastic container	✓				*Risk of milk spoilage
Lack of access to essential amenities (toilets, difficult to clean floors, poor waste disposal, poor drainage systems), poor personal hygiene		✓		✓	*High risk of milk contamination
Inappropriate housing for animals (cow sheds connected to main houses)			✓	✓	*High risk of milk contamination
Lack of knowledge (retailers)		✓			*Risk of unsafe milk entering the food chain
Conflicting hours of operation (hawkers, traders, roadside vendors operate very early or late (when government facilities have closed)	✓	✓	✓		*Risk of unsafe milk entering the food chain
High cost of getting into premises is prohibitive for hawkers and roadside vendors			✓		*Increase of unregulated chains which are difficult to monitor and regulate
Lengthy process of sanctioning which takes 1 – 3 months		✓			Reduced incentive to enforce compliance
Compliance issues within lower socio-economic strata	✓		✓		*Risk of unsafe milk being sold
Sick animals which do not respond to antibiotic treatment are sold to butchers or traders				✓	*Risk of unsafe milk being sold
Farmers not observing antibiotic withdrawal period				✓	*Risk of unsafe milk being sold

Grace, 2014). However, the mode of operation for the certified traders was like those of uncertified traders, raising speculations that traders were seeking to legitimize their businesses rather than improve how they conducted business (Kiambi et al., 2018). Traders escape harassment from regulators when they have a certificate, but they continue with their original practices. Furthermore, Alonso et al. (2018) found that there were no differences in bacterial quality of milk sourced from trained and untrained traders, and hence highlighted the interlinkage in the system and the difficulties in applying incentives to increase milk quality. This may also explain the numerous food safety problems identified at the retail nodes in the current study. Among those mentioned were sale of raw milk to consumers, adulteration (addition of water or other substances like margarine and flour), value addition of spoiled milk to be sold at cheaper prices and the addition of hydrogen peroxide or formalin to preserve the milk for long distance transportation without a cold chain. In addition, the findings indicate that farmers could easily switch traders/retailers who questioned the quality of their milk, implying that there is low power to sanction farmers

Table 9
Governance themes identified by government officers.

Governance themes	KDB	City council	PHOs	LPOs	Food safety implications (*authors' view)
Failure of traders and retailers to obtain licenses	✓	✓			*Sale of milk by unlicensed traders and retailers means milk escapes regulation and monitoring for food safety risks
Hawkers lack of permanent milk trading premises makes it difficult to apply sanctions	✓	✓			*Increase of illegal business difficult to regulate and enforce
Specialized team from city council regulates roadside vendors and hawkers with semi-permanent infrastructure (e.g. cess collection)		✓			*City council's collection of revenue from unlicensed traders and retailers escalates further sales of milk that is not monitored by KDB for food safety risks
Political interference (politicians prevent closure of noncompliant businesses)		✓	✓		*Encourages unregulated chains which are difficult to monitor and regulate
Fragmented licensing (same city council, different offices handle various licenses that traders are required to obtain)	✓				*Increase of illegal business difficult to regulate and enforce
Traders and retailers in semi-permanent structures do not have licenses but pay daily cess	✓	✓			*Increase of illegal business difficult to regulate and enforce
Conflict of interest; it is illegal to sell milk without premises and licenses, but revenue is still collected from illegally operating businesses like hawkers and roadside vendors		✓			*Encourages unregulated chains which are difficult to monitor and regulate
Retailers not willing to obtain licenses due to high cost and their perceived lack of value due to inadequate services like fluctuating electricity and poor roads	✓	✓			*Increase of illegal business difficult to regulate and enforce
Livestock keeping is illegal in the city and farmers (in city) cannot be licensed		✓		✓	*Prevents farmers from seeking services from government
Retailers in high-income areas do not have a problem with compliance (90%)		✓			
Provision of training on food handling to retailers	✓	✓	✓		
Uncompliant retailers/traders (licensing) are given a 14-day notice to comply, otherwise arrested and taken to court (to scare the rest), or may have their businesses closed or milk confiscated		✓	✓		

based on food safety, thus increasing the risk for unsuitable milk to enter the distribution chain. To ensure monitoring of food safety hazards in a complex system like Nairobi, the relevant sector requires an understanding of critical areas that require minimum interventions to achieve maximum impact. Proper incentives and rewards may be critical to enable effective transformation of the sectors. For example, the sector may need to invest in educating consumers who will then demand quality milk. Publicly subsidizing various inputs may also provide incentives to ensure milk quality. Training alone is not adequate as shown by Alonso et al. (2018), but increasing both the demand for a safe product and the earning potential of the value chain actors based on the quality of their product will provide incentives to follow food safety regulations. Policymakers must also take into consideration that the informal sector employs about 80% of the people working in the dairy sector; thus many people depend on the informal dairy sector for their livelihoods and it is a path to reduce poverty, hunger and malnutrition (Salasya et al., 2006).

At the dairy cooperative and large processing company level, the main challenges influencing food safety were the low milk quality (adulteration, lack of cold chain and lack of withdrawal following administration of medicines) and lack of policies for management of milk that has been rejected at reception with the rejects being resold to competitors (traders). The quality of milk reaching the processing unit defines the final quality of processed milk. Yet there are weak support services to farmers which contributes to hygienic milk production and handling. Considering that farmers are just a small proportion of the country's small scale producers, it is not surprising that such challenges are major reasons for the lack of milk quality differentiation between formal and informal systems (Alonso et al., 2018; Roesel and Grace, 2014; Salasya et al., 2006). Strict standards are not enough to ensure that high-quality milk is supplied to cooperatives and large processing companies. Farmers and distributors require capital to produce and deliver a quality product. Farmers also require access to affordable veterinary care, and both farmers and distributors require infrastructure such as adequate roads.

Dairy cooperatives and processing companies report that they accept milk that should be rejected because of a lack of clear policy regarding management of rejected product. These entities reported that if milk is rejected by them, it flows back into the food chain through their competitors; as a result, they opted to accept it and assumed that it would be diluted when mixed with other good milk. If such milk were colored differently, or disposed of at reception, it may incentivize the formal systems to adhere to quality control measures and enhance compliance with food safety regulations.

The current study has established that lack of compliance to rules and regulations was common as seen by the reluctance of various actors to obtain licenses and permits. Ideally, business licenses and permits are mainly used for purposes of taxation, but they also help the government monitor and regulate businesses that may affect public safety. This study has identified the fragmented, costly and complex regulatory system as a barrier to compliance and to formalization of milk enterprises. This agrees with other studies (Alonso et al., 2018; Pfeffermann, 2001). Often, lack of coherence in policy and practice (fragmented system) results in one arm of the government doing something that is contrary to the other arm of the same government. For example, although it was illegal and strongly prohibited by KDB to hawk or trade milk in open (without premises), the city council organized a team that collected revenue from these businesses and charged a daily fee (not necessarily a license or permit). Other studies agree that lack of integrated regulatory functions is a problem in the dairy sector globally but local authorities drive the required changes based on their identified challenges (Gereffi et al., 2005; Orden and Roberts, 2007). For example, Gereffi et al. (2005) argues that when demand and supply are fragmented, there is a higher likelihood of having no or limited public standards that cover only basic food safety aspects (Gereffi et al., 2005). Such systems are characterized by less developed private quality and social and environmental standards. Hence, as it is, the Nairobi dairy system will be difficult to organize until licensing is integrated and costs reduced. If most people continue to run businesses informally, the few numbers of regulators will continue to be overwhelmed with non-compliant people. But once the system is organized, it means the stakeholders will be known and it will be possible to provide systematized training, monitor food safety hazards and enforce the law.

While food safety concerns arise from both formal and informal systems (Alonso et al., 2018; Roesel and Grace, 2014), and considering the tight interactions among actors in both systems (Kiambi et al., 2018), the government should find a common ground to holistically address food safety challenges. Sound policy reforms have been shown to have widespread economic benefits (Alonso et al., 2018; Pfeffermann, 2001; Salasya et al., 2006). For example, the Nairobi dairy value chain is vast and formal chains are somewhat integrated with informal chains (Kiambi et al., 2018). So, emphasis on criminalizing and penalizing actors in the informal chains without addressing factors that hinder formalization directly impacts on possible gains that are desired by the system, like food safety and food security. Consequently, even the formal chains may not function optimally, as seen in their struggle to reject any milk. In this study, it was reported that sometimes dairy cooperatives and large processing companies received milk that should be rejected. They argued that considering milk is scarce and there is always a ready milk market, if the formal systems rejected such milk, the supplier will always find another outlet and that milk will get into the food chain through other channels and thus the formal systems will be the losers.

Unfair competition was reported as another governance issue driving compromised food safety, particularly by large processing companies and dairy cooperatives (formal sector). These actors cited a lack of protection by KDB from the informal sector who were said to trade freely with minimal costs and without licenses, and yet they dominated the milk market. The frustration in regulation of the informal sector was described from the aspect of KDB's attempt to formalize the informal sector (Leksmono et al., 2006). This is also seen in the current study where city council officials charge a daily fee for the noncompliant traders and retailers (hawkers or selling outside a premise which is against the law). However, the central question is what food safety value is added with more flexible regulation and increased compliance? More studies are needed to fully understand this relationship, particularly in systems where the milk structure is vast and liberalized like in Nairobi. Consumers are always looking for value in whatever commodity or services they seek. In the Nairobi milk system, it seems the government is not adding value through regulation, seen by the enormous number of people trading without licenses. These actors felt like regulation was an extra burden that increased operational costs without increasing profit potential. As a result, out of the 56,446 traders in the country, only 2203 were active in DTA (879 in Nairobi). Therefore, large amounts of milk was flowing through the informal milk marketing channels as demonstrated in other studies (FAO, 2011a). However, other researchers argue that regulation enhances food safety, but this is possible only in systems where government regulation incentivizes product quality linked to increased profit potential and the infrastructure supports business development (Gereffi et al., 2005). Otherwise, if regulation does not offer any added value to both producers and consumers, consumers will continue to obtain milk from informal sources. Consumer will need to push for quality for effective transformation, but with a rapidly increasing population (especially poor people), quality may not necessarily be the priority.

In the current study, various sanctions were mentioned to enforce regulation. These included negative sanctions like rejections of poor-quality milk from farmers and suppliers, deregistration of members from cooperatives for breaking agreements, prosecution of defiant traders and positive incentives such as payment of bonuses. But why is it that milk safety is not improved with the prevailing sanctions? According to Kaplinsky and Morris (Kaplinsky and Morris, 2000a), the

power to govern requires the capacity to sanction behavior directed against transgressions (the “stick”) and a reward system for conformance (the “carrot”). Considering our results, we argue that there is a clear need to organize milk marketing in the city to enhance adequate governing. Incentives must consider the fragmented governance system (KDB, city council, public health offices), milk scarcity and high demand, which leads to ease of selling mild that has been rejected elsewhere. As it is currently, incentives may not be strong enough to counter illegal practices and the benefits for not complying are higher than the losses that come with being caught up by the law.

4.1. Policy implications

There are challenges in achieving food safety goals within the current formal regulation framework which has enough provisions for promoting food safety (Dairy Industry Act, Public health ACT, Legal Notice No.209 of 2011 Veterinary and Paraprofessionals ACT). However, compliance to various rules and regulations is hindered by the complex procedures for acquiring the multiple licenses and milk trading permits which are also expensive. At the same time, there appears to be added advantage for most traders who do not comply with official rules and regulations since they are able to successfully compete at milk sourcing and marketing while they evade regulation.

Our analysis highlights the importance of understanding governance to improve food safety. There have been previous attempts aimed at organizing the dairy sector through formalization of the informal sector among other efforts to improve food safety (Omore and Baker, 2009). In Kenya, formalization involves obtaining several licenses and permits (see example in Table 5), a premise that must comply with specific hygienic and operational requirements (KDB, 2020), milk handling in aluminum/food grade containers and observing cold chain compliance. We argue that while all these measures could serve to safeguard food safety, the impacts could be anti-poor, and pro-big business not favoring most of the small-scale actors who form the vast and complex Nairobi dairy value chain. Formalization of the dairy value chain needs to be adaptive to the requirements of the poorest producers and other actors. The government needs to be cognizant of the different actors in terms of scale and capacity so that regulation considers and develops tailored interventions which could be regulated and charged accordingly (there should not be a one size fits all).

Formalization of the informal sector would require re-alignment of the fees and licenses in the system. Rather than each regulatory body raising revenues through small-scale charges imposed on every actor (e.g. the daily cess fees which should be charged to transporters only, but which is charged to all actors), charges could be more centralized through an income tax-based system or other centralized form of revenue generation. No doubt this would require some realignment of government institutions and their mandates; in developing economies, some level of political buy-in would no doubt be required for this. Realigning the sector would also impact the public health and veterinary inspection systems relevant to dairy farming and marketing. Much of the time, these inspections are the basis for ad hoc fees. A key policy question to be addressed is how to improve regulation without resulting in a ballooning ad hoc inspection system. There may be innovative ways to involve the private sector and/or self-regulation by farmers and, in particular, farmers groups, in this process. Training in best practice for all value chain actors would be an essential component of this.

Some studies have emphasized the value of organized milk trading systems as a means of improving food safety and governance (Alonso et al., 2018; Omore and Baker, 2009). However, we clearly show that subscription to these groups remains very low (Kiambi et al., 2018) and that membership is usually motivated by a desire to legitimize existing practice rather than adopt improved practices. The problematic nature of informally constituted groups is that their trade undermines the value proposition of larger scale players in the system, and they are therefore seen as threatening to the formal sector business model. If these groups are to expand their footprint, some mechanism to ensure that they are operating in a fair market is required.

There are some limitations and weaknesses that would be important in interpretation of results from this study. First, data were gathered mainly through narrations from KIIs and FGDs. Therefore, the actual magnitude of food safety risks driven by challenges and governance issues described in this study have not been quantified. However, efforts were made to interview a wide range of people ensuring adequate triangulation to minimize errors. Risk assessments and microbiological studies would be valuable to further identify and characterize the presence of hazards and milk quality in the system.

Second, although the dairy sector is important in the country, data collection concentrated on milk chains supplying Nairobi and therefore the results may not be generalizable to the country, particularly more rural areas. Nevertheless, emerging issues as stated by KDB, LPOs and PHOs may reflect the country’s situation and the methodology utilized for this study may be replicated to study the country’s dairy industry. Lastly, due to the complexity of interplay between challenges, governance and their implications on food safety, the study does not provide a straightforward solution. However, the study has identified key considerations for improvement of the dairy value chain. A systematic economic analysis of incentives and distribution of benefits may provide a more dynamic view of how the complex dairy value chain may be satisfactorily governed.

5. Conclusion

This study has highlighted the implications of various challenges and governance issues on food safety. Just as the Nairobi’s dairy system is fragmented and interdependent, so is the diversity of actors’ relationships, and food safety implementation approaches and practices. Governance themes were related to weak relationships between government and various stakeholders, unfair competition in the system and the high cost of multiple licenses through complex procedures. These were some of the key drivers triggering noncompliance to official rules and regulations thus triggering of food safety themes that included inadequate training and extension services; inadequate access to cold chain facilities, adulteration and low milk quality delivered to dairy cooperatives and large processors, and lack of food safety training. The range of issues highlighted are based on stakeholders’ perceptions and reflects the complexity of the relationships between them. Many of the governance themes demonstrate the linkages that are both beneficial or confrontational between the formal and informal sectors, and between industry and regulatory authorities, with possible direct food safety consequences. Findings obtained provide indications to decision-makers of potential governance areas that could help improve efficiency and food safety along the dairy value chain.

Ethical approval

Ethical approval for this study was obtained from the International Livestock Research Institute Institutional Research Ethics Committee (project reference: ILRIIREC2014-04/1). ILRI IREC is accredited by the National Commission for Science, Technology and Innovation (NACOSTI) in Kenya. Ethical approval was also obtained from the Royal Veterinary College ethics committee (project reference: URN 2013 0084H).

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.prevetmed.2020.105009.

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